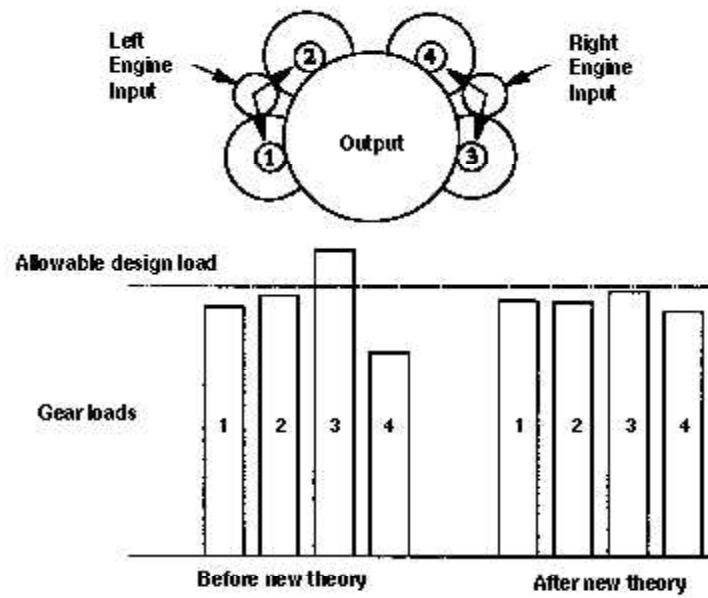


Code to Optimize Load Sharing of Split-Torque Transmissions Applied to the Comanche Helicopter

Most helicopters now in service have a transmission with a planetary design. Studies have shown that some helicopters would be lighter and more reliable if they had a transmission with a split-torque design instead. However, a split-torque design has never been used by a U.S. helicopter manufacturer because there has been no proven method to ensure equal sharing of the load among the multiple load paths. The Sikorsky/Boeing team has chosen to use a split-torque transmission for the U.S. Army's Comanche helicopter, and Sikorsky Aircraft is designing and manufacturing the transmission. To help reduce the technical risk of fielding this helicopter, NASA and the Army have done the research jointly in cooperation with Sikorsky Aircraft. A theory was developed that equal load sharing could be achieved by proper configuration of the geartrain, and a computer code was completed in-house at the NASA Lewis Research Center to calculate this optimal configuration.

The prototype split-torque transmission for the Comanche helicopter was designed and built before the new theory and computer code were available, and the measured loads on the four final drive gears of the prototype were not equal. In fact, one of the gears was loaded beyond the allowable design load. The new theory and computer code correctly predicted the trend of the loads for the prototype design, and the code was applied to calculate small, but important, design changes to theoretically balance the loads on all four gears. The code calculates how elastic deformations affect the relative amount of load carried in each load path. The deformations that were considered in the analysis were tooth bending, gearshaft twist, gearshaft bowing, housing deflections, and the Hertzian deformations at bearing rolling element and raceway contacts. The design changes calculated to accommodate the deformations were manufactured, and the test of the redesigned transmission proved that the load sharing was greatly improved. As shown in the figure, the loads on the four final drive gears are now nearly equal, and all loads are less than the allowable design load. A significant amount of development time and money was saved by applying the analysis to achieve good load sharing with only one design iteration.

The new theory and computer code have been validated, and a patent application has been submitted for this technology with Government and Sikorsky personnel as coinventors. We plan to continue to support Sikorsky Aircraft with transmission technology from Lewis and the Army as needed to bring the Comanche gearbox design to maturity.



Measurements of loads on the four final drive gears prove the new theory to ensure load sharing.